Control strategies for demand controlled ventilation (DCV) in dwellings

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DCV – yearly savings potential

Assume DCV gives 25 % reduction in average air flow

Specific fan power is constant

		Heat energy kWh/m²	Electric energy kWh/m²	Primary energy kWh/m²
Natural ventilation		39		39
Minimum requirements in Danish Building Regulation 2010	CAV HE 80% SFP 1000 J/m³	25	2.6	31.5
	DCV HE 80% SFP 1000 J/m³	23	1.9	27.8
Efficient system and air tight building envelope	CAV HE 90% SFP 600 J/m³	13	1.6	17.0
	DCV HE 90% SFP 600 J/m³	12	1.2	15.0

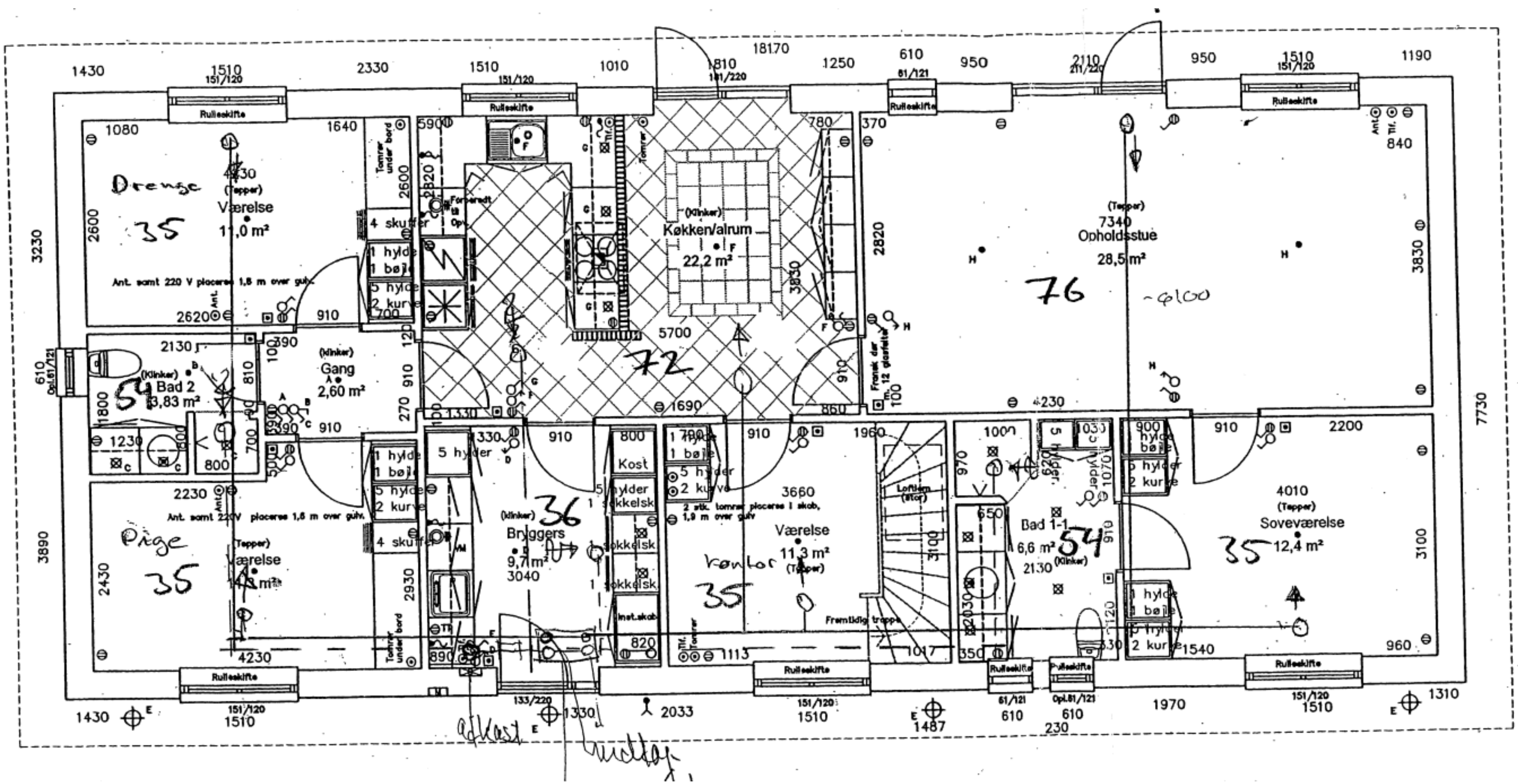
House of 140 m²: Heat saving 140 kWh - 280 kWh

Electric saving 56 kWh - 98 kWh

Aim of the study

- To do a full scale testing of strategies for DCV in a dwelling with balanced mechanical ventilation
- Focus especially on indoor environment: air quality (CO_2) and humidity
- Show that DCV can provide indoor environment equal to CAV

Test case – 140 m² single family house



Control strategies

- Simple strategy – control at whole house level

  Control: CO_2, RH and temperature measured in inlet and exhaust air

  Only speed control of the fans

  Switch between two air flow rates 0.43 l/(s m²) and 0.16 l/(s m²)

  If $\Delta CO_2 < 150$ ppm

  If $\Delta x < 2$ g/kg

- Complex strategy – individual room control

  CO_2 measured in each living room

  RH measured in bathrooms

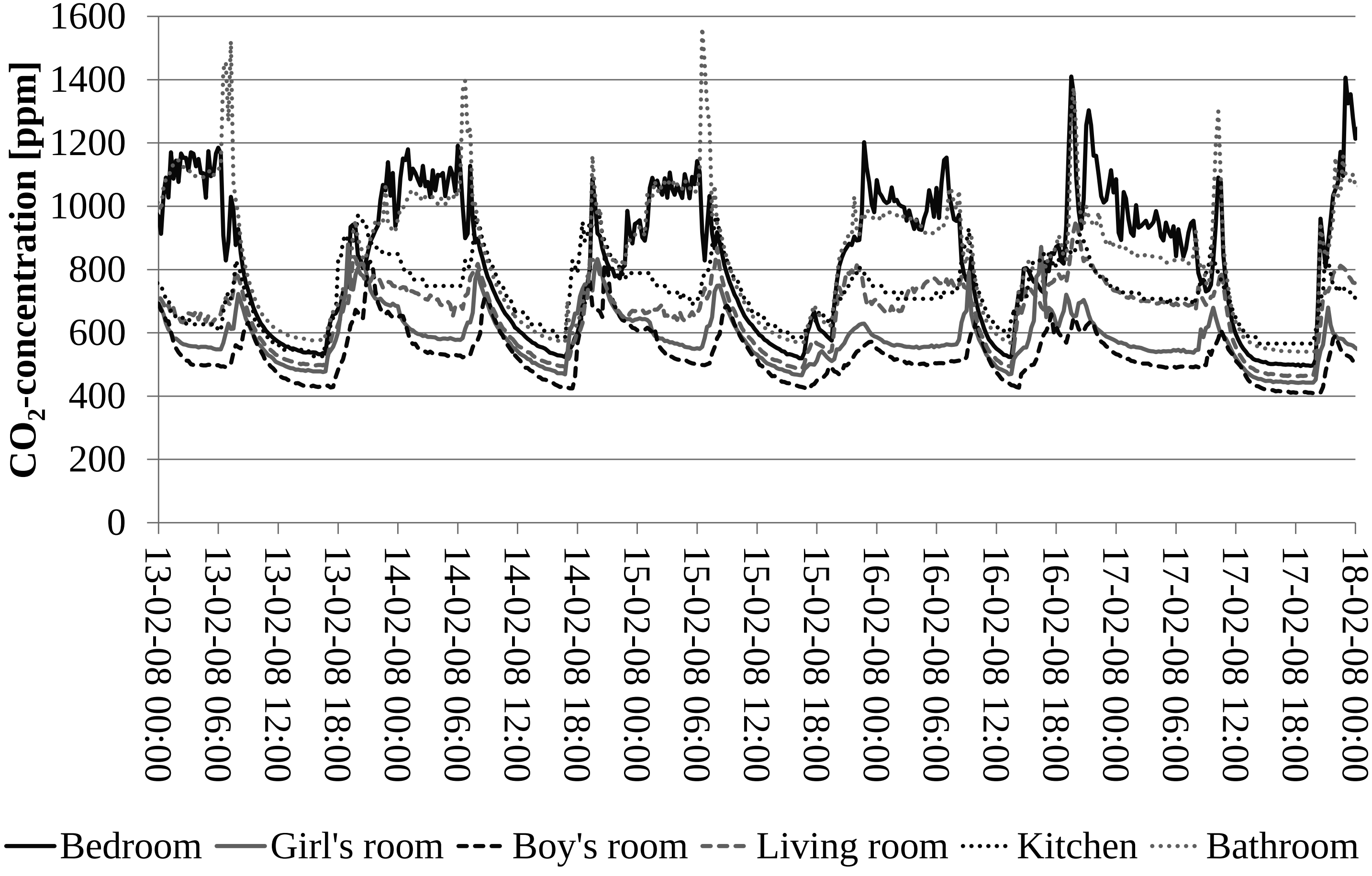
  Damper for each inlet terminal (from 100% to appr. 30% air flow)

  Speed control of fan based on constant static pressure

  Room CO_2-setpoint 800 ppm

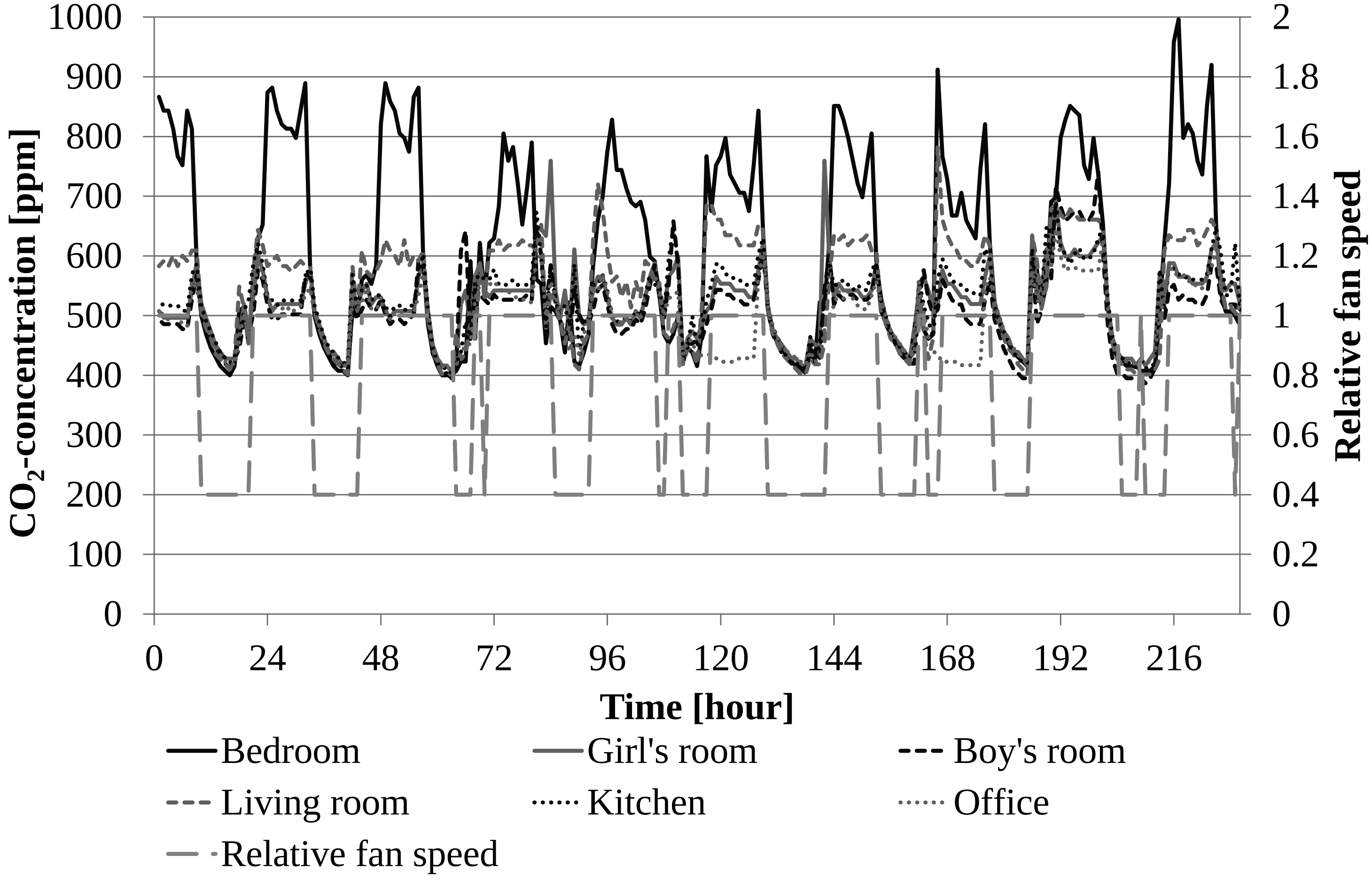
  Max. air flow if relative humidity is above 80% in one bathroom

Results CAV

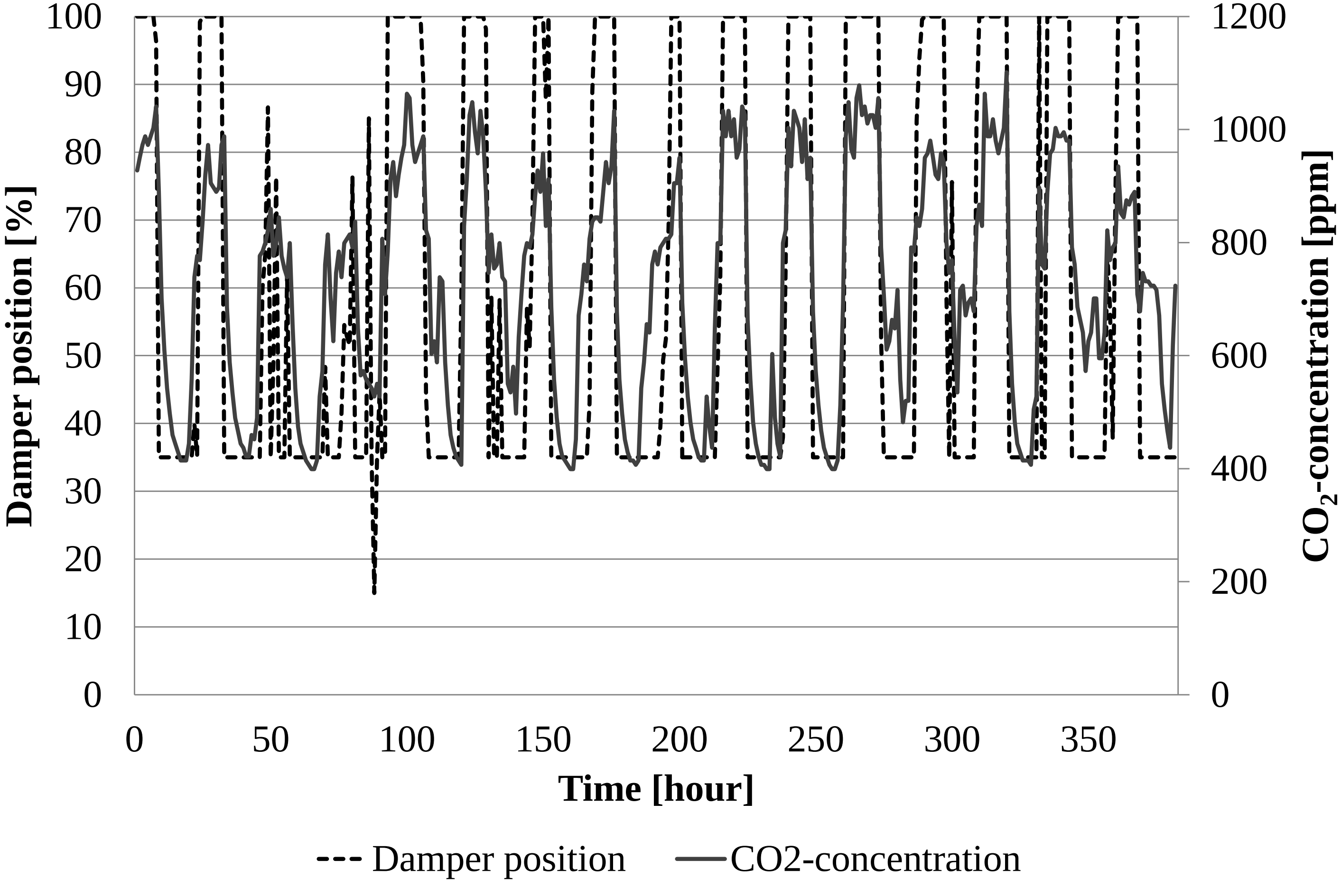


1600
1400
1200
1000
800
600
400
200
0
CO_2-concentration [ppm]
13-02-08 00:00
13-02-08 06:00
13-02-08 12:00
13-02-08 18:00
14-02-08 00:00
14-02-08 06:00
14-02-08 12:00
14-02-08 18:00
15-02-08 00:00
15-02-08 06:00
15-02-08 12:00
15-02-08 18:00
16-02-08 00:00
16-02-08 06:00
16-02-08 12:00
16-02-08 18:00
17-02-08 00:00
17-02-08 06:00
17-02-08 12:00
17-02-08 18:00
18-02-08 00:00
Bedroom
Girl's room
Boy's room
Living room
Kitchen
Bathroom

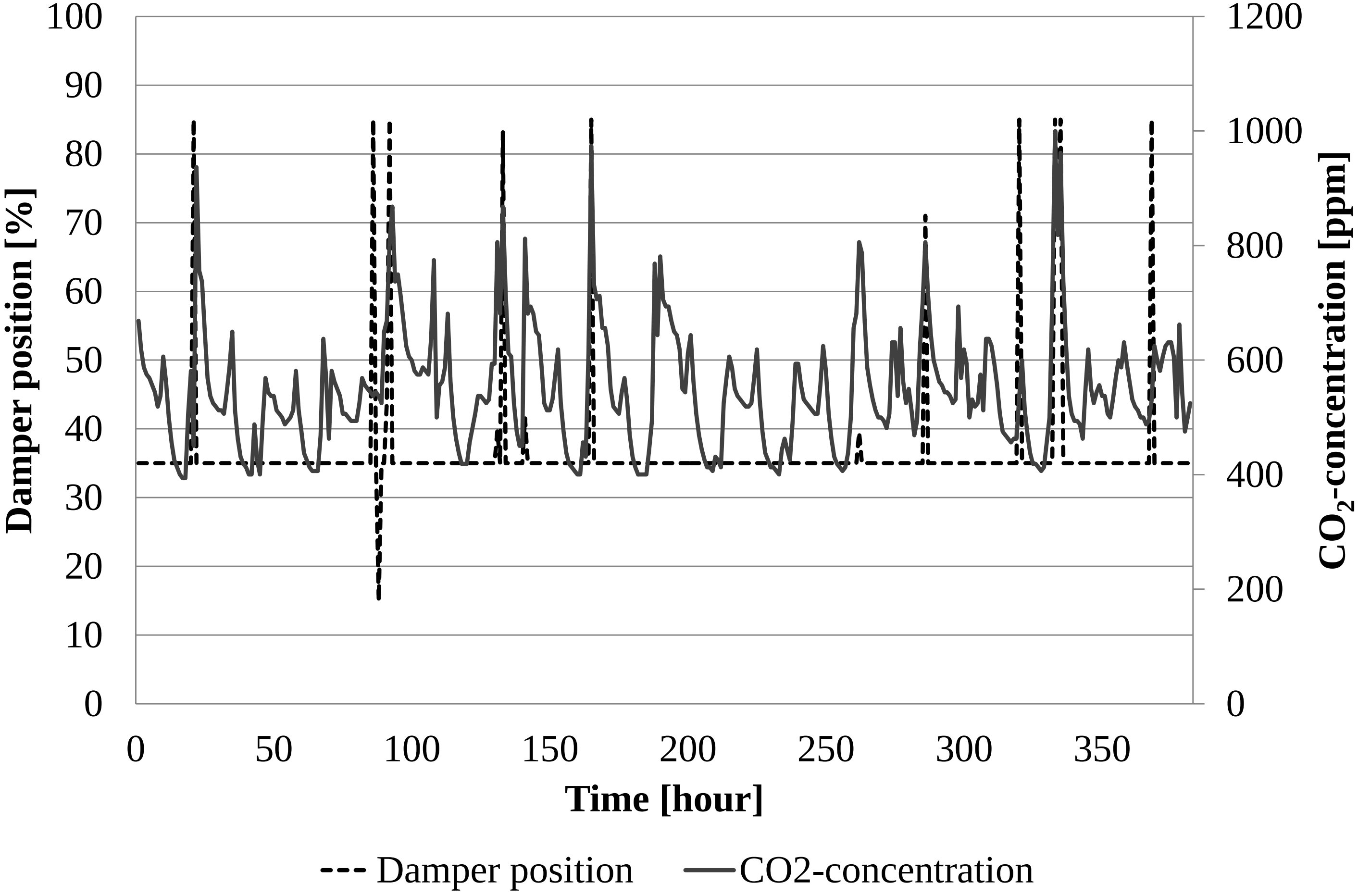
Results simple control strategy



Results complex - Bedroom



Results complex – Boys room



Conclusion

- Two control strategies for demand controlled ventilation have been tested in a single family house used by two adults and two children.
- Measurements showed that the simple control strategy reduced the average air flow by 25 % which gives a theoretical 35 % saving on electric energy for fans.
- The complex control strategy resulted in a lower average air change rate in the house compared to the simple control. The result is an increased CO_2-concentration in some rooms compared to the simple control. Therefore, the air quality in some rooms is reduced.
- It is concluded that it is possible to reduce the average ventilation flow rate in dwellings without significant negative impact on air quality or moisture levels.
- Savings are too small justify significant extra investment